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Precast shelving units for residential houses

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The paper describes a precast concrete shelving unit which has been developed for use in residential buildings. There are three basic shapes and two dimensional variations in each direction, namely 40 or 60cm along the length, 30 or 60cm along the depth and 20 or 30cm in height. A broad range of fourteen versatile units have been developed to provide innumerable combinations for kitchen shelving, wardrobes, study table with book-shelves and general shelving. The units are simple to produce and easy to handle. They are assembled as the masonry work progresses. An overall economy of about 50 per cent can be achieved as compared to conventional shelving. The scheme being an open one, the architect, builder or user can decide the location and final form of a configuration according to individual requirements.

"A place for everything, and everything in its own place"—is a requirement for every housewife. Designers should follow the same slogan. But unfortunately very little attention has been given to the storage space in a house, which, is in fact, one of the most important factors governing living comfort. Functionally located, optimum storage spaces enhance the use-efficiency of a house. Although there is certain information available about the storage space requirements in the house no complete shelving scheme is readily available[1 to 5].

A study to evolve an economic easy to build shelving/storage system, which can be conveniently adopted for all sorts of storage spaces in various types of houses, and to produce a ready reckoner for designers, was undertaken.

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The design

The design of any functional product is governed by three basic considerations, *viz.*, function, structure and aesthetics. These considerations have been applied in this study as well. The storage units have been designed on the basis of articles to be stored, their sizes, the way of stacking and their use frequency. Commonly used articles stored in different spaces are listed in *Table* 1. Other relevant data like total storage volume required in different types of houses, depth and height components of individual shelves, is also indicated in the table.

A detailed study and analysis of the table leads to the formation of a 20-cm × 10-cm grid (20 horizontal,

TABLE 1 Storage space requirements in different spaces of the house

Living room (entrance lobby)	*Kitchen + dining + store + pantry*	*Bed + box room*	*Bath (inside or outside)*
Volume of space			
0·25m³	1·7m³ to 2·0m³ for lower-income group	2·0m³ for lower-income group	
	3·0m³ to 3·25m³ for middle-income group	1·8 to 2·0m³ for middle-income group	
		3·5m³ for single person accommodation	
Articles stored			
books, curios, radio and musical instruments, shoes,* umbrellas, sport rackets, etc.	utensils, tins containing food grains, vegetable basket, kothi, jute sack, drum etc., cooking equipment, stove, gas cylinder, saucepans, parat, cooker, bhagonas, thalis, bowls, jug, tumblers, spoons, etc.	clothes, bed covers, blankets, quilts, suitcases, trunks, mirror, cosmetics, sewing machine, books, shoes, sport rackets, umbrellas	soaps, paste, brushes buckets, mallet, linen etc.
Inference			
required depth 30† minimum individual shelf height 20 maximum individual shelf height 90	required depth 30 and 60 minimum individual shelf height 20 maximum individual shelf height 90 cooking platform level 75	required depth 60 minimum individual shelf height 20 maximum individual shelf height 120 study top level 70 to 75 maximum level of daily use shelf 180	required depth 30 minimum individual shelf height 20 maximum individual shelf height 50

Notes : (*i*)* in southern states it is preferred to place the shoes in the entrance lobby.
(*ii*)† dimensions in centimetres (unless mentioned otherwise).
(*iii*) suitable grid for the shelving scheme consists of 40, 60, 80 and 100 in X-direction ; 30 and 60 in Y-direction ; 20, 30, 40, 50 and 60 in Z-direction,

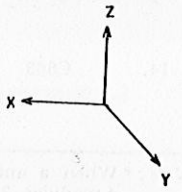
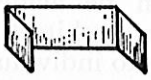
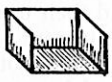
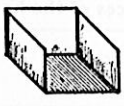
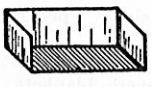
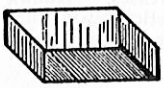
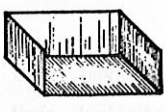
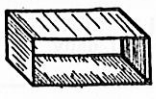
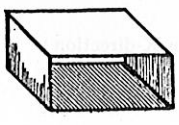
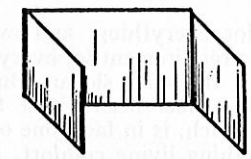


TABLE 2 Schedule of shelving units

Serial no	*Description*	*Unit*	*Weight,* kg	*Total cost,* Rs	*Illustration*
1.	A433		18	5·35	Basic shapes A, B, C*
2.	A463		26	6·40	
3.	A633		20	5·90	
4.	A663		30	6·65	
5.	B432		16	5·00	
6.	B433		23	5·55	
7.	B462		26	5·95	
8.	B463		26	6·00	
9.	B632		23	5·60	
10.	B633		30	6·25	
11.	B662		39	6·85	
12.	B663		50	7·85	
13.	C633		30	6·25	
14.	C663		60	9·05	



Note : * When a unit is described as A433, it means it has a basic shape A, with dimensions along X-axis, Y-axis and Z-axis as 4 modules, 3 modules and 3 modules respectively, where a module = 10cm.

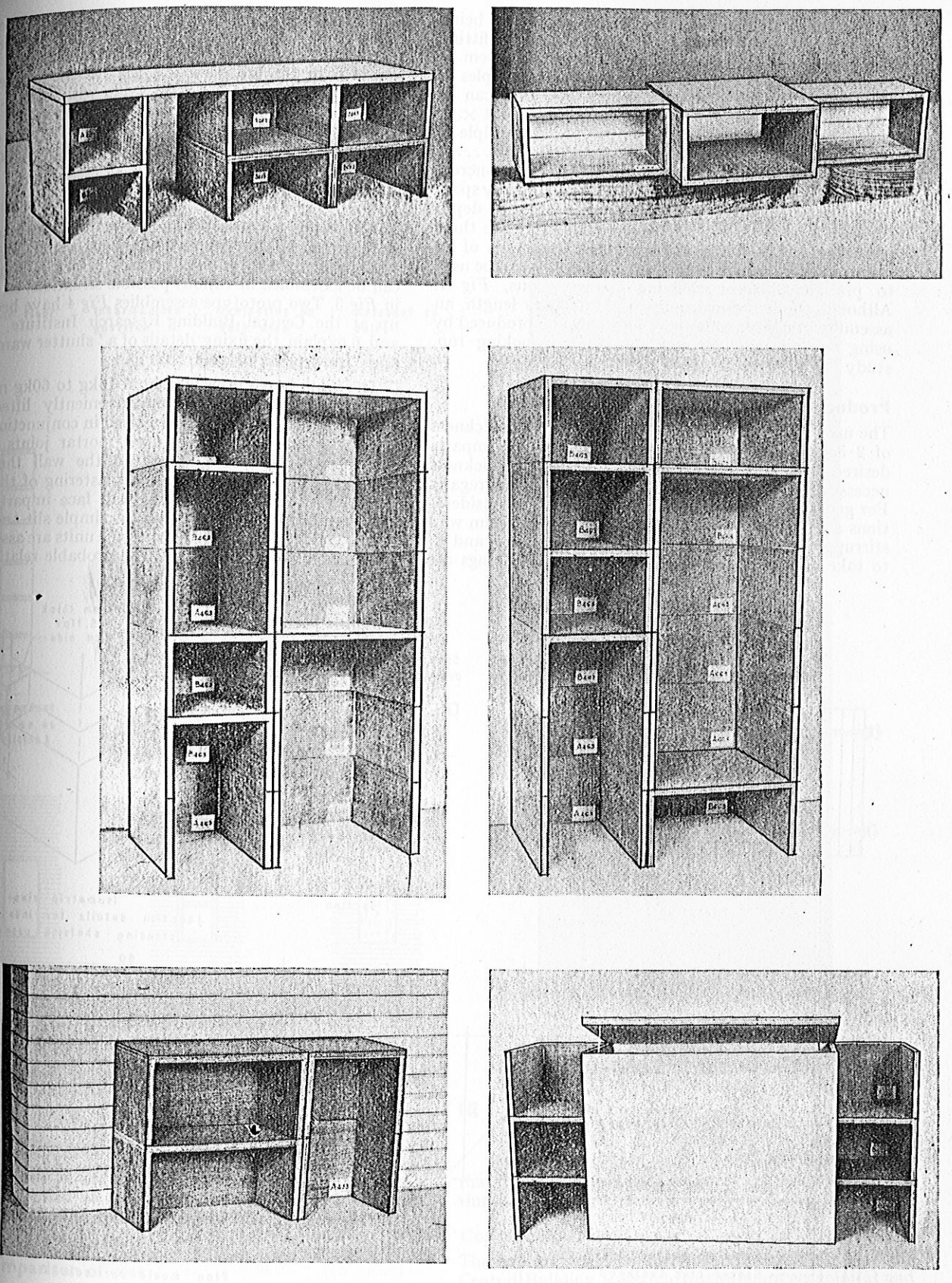


Fig 1 A few model assembly configurations, showing cooking shelves and platform, book cabinet, wardrobes, general shelf, and suit-case and quilt storage

10 vertical) with the third dimension, *i.e.*, depth being kept constant at 30 or 60cm. The smallest unit fitting in this grid has been kept at 40 × 20cm with 30cm as depth. This permits any shelving length in multiples of 20cm. For example, an overall length of 240cm can be achieved by using 4 × 60 or 6 × 40 or 2 × 60 + 3 × 40 units. Similarly an overall height of 110cm (multiple of 10) can be formed by using 3 × 30 + 1 × 20..... and so on. A spectrum of 14 versatile precast concrete units shown in *Table* 2 has a potential to fill up any space within the 20cm × 10cm grid with 30 or 60 as the depth component. It can be clearly seen that there are three basic shapes A, B and C having 4, 8 and 12 types of dimensional variations respectively. These units can be used to provide different shelving configurations, *Fig* 1. Although the individual units are of modular length, an assembly of non-modular length can also be produced by using one non-modular component ; *viz*, cooking top, study top, etc.

Production

The units are three dimensional, having a wall thickness of 2·5cm. It is the geometry of shape which imparts desired strength to the units[6]. The small thickness necessitates the use of minus 10-mm coarse aggregate. For good workability, finish and the strength considerations a 1 : 3 : 3 mix has been used. U-shaped 3-mm wire stirrups at 10-cm centres are provided in units A and B, to take care of handling stresses. In unit C, rings are provided. The shape A is less strong at the corners as compared to shape B and C, due to lack of angular stability. Extra corner, four 6-mm diameter steel provided in the unit, imparts the necessary strength. All the units are easily produceable with normal skill. No vibrator is necessary for the production. Split moulds made of timber, *Fig* 2 were used to produce the units, however, steel moulds are to be preferred for commercial production.

Assembly

The units are assembled simultaneous with the masonry work in the house. The commonly used unit height of 30cm is equivalent to four courses of brick. The units can be assembled in various possible situations as shown in *Fig* 3. Two prototype assemblies *Fig* 4 have been put up at the Central Building Research Institute, *Figs* 5 and 6 explain the fixing details of a ' shutter wardrobe ' and ' front plank of quilt box '.

The units range in weight from 16kg to 60kg making it possible for them to be conveniently lifted and placed by two persons. When placed in conjunction with masonry work they have simple mortar joints at the interfaces. If placed adjacent to the wall they are assembled in position before the plastering of the wall. The plastering of the adjoining wall face imparts additional stability to the assembly. A simple slit and plate arrangement, *Fig* 2 is useful when the units are assembled independent of the masonry. The probable relative dis-

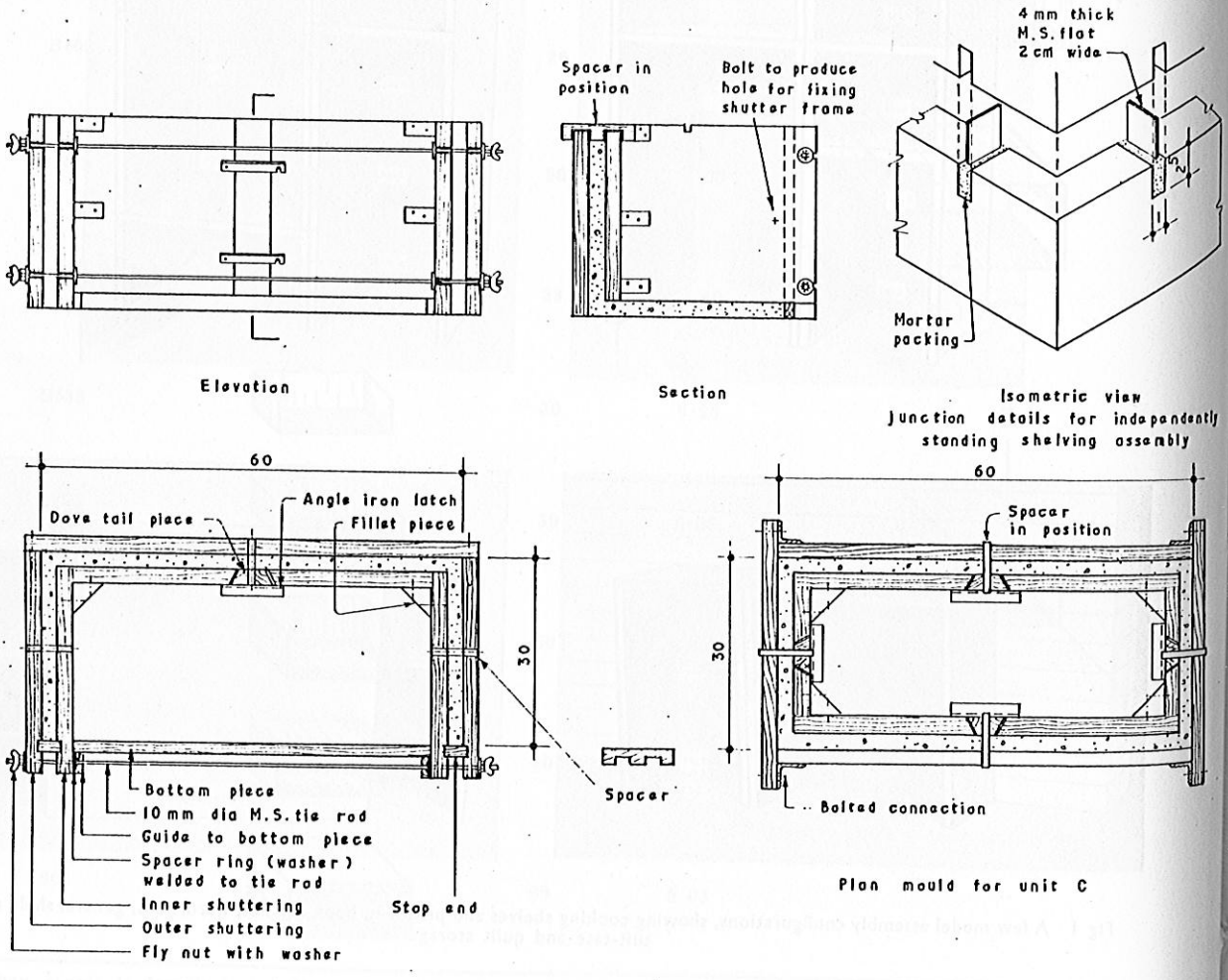


Fig 2 Mould details

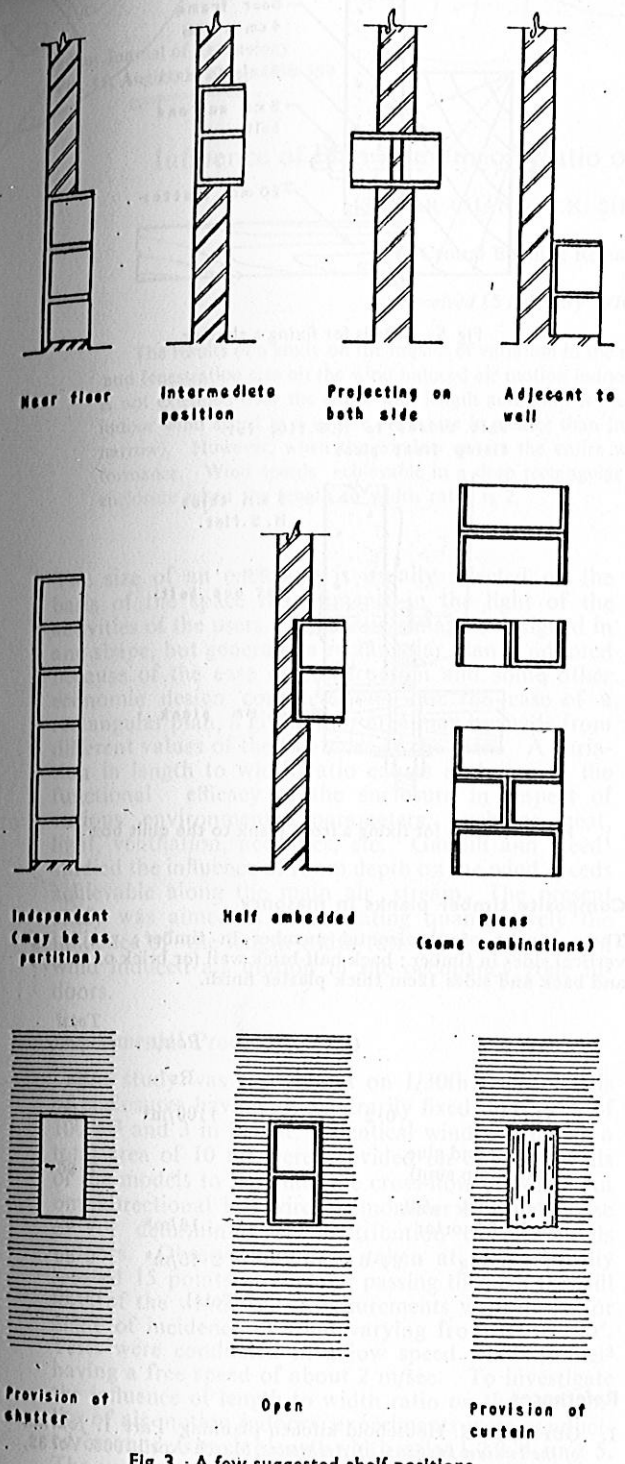


Fig 3 · A few suggested shelf positions

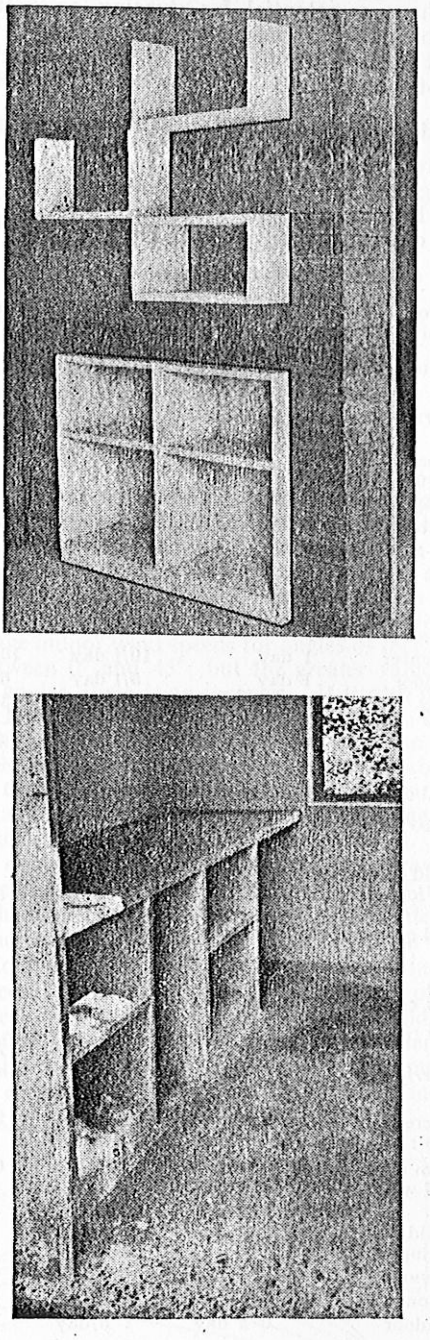


Fig 4 Prototypes of general shelving and kitchen shelving set up at the Central Building Research Station

placement of the units due to an accidental lateral force is prevented as the slit-plate arrangement in the two adjoining sides is perpendicular to each other.

Comparison of cost

To compare costs a typical precast shelving unit B633 is taken as an illustrative example. The detailed cost analysis of the unit alongwith the conventional composite shelving, with timber planks in masonry and total timber shelving is given in the *Appendix*. The comparison shows that the cost of this new concrete shelving is half that of the composite shelving and one-third that of full timber shelving.

Conclusion

The precast concrete shelving units developed at the Central Building Research Institute are economical and durable compared to traditional timber shelving. These units can be conveniently adopted for various storage spaces in residential houses.

They can be used in a number of ways other than those shown in the illustrations. For example, C663 and C633 can be used as dust bin, coal bin or grain storage

space. The scheme with certain modifications can be used in office buildings, school buildings etc.

The facial proportions, namely 1 : 2, 1 : 3 and 3 : 4 of the units have a potential for creating aesthetically sound combinations. The scheme being an 'open' one an architect has a free hand in deciding the location and final form of combination.

Acknowledgment

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Appendix

Comparison of costs with composite and total timber shelving. A typical unit B033 has been considered for comparison.

Cost of mould

(I) — *Material*	*Quantity*	*Rate*, Rs	*Total amount*, Rs
Timber (including 20 per cent wastage)	$2 \cdot 13 \times 10^{-2}$/m³	1100/m³	23·40
Ten steel tie rods	0·87kg	1·80/kg	1·60
Nuts and washers			1·00
			26·00
(II) — *Labour*			
Carpenter	1 day	10/1 day	10·00
Mazdoor	1 day	5/1 day	5·00
Fitter	0·3 day	10/1 day	3·00
			18·00

Total of I + II = Rs 26 + Rs 18 = Rs 44.

Assuming fifty uses of the mould:

	Rs
Mould cost/casting	0·88
Add for repairs and oil	0·12
Total mould cost/modulus casting	1·00

Production cost of one module unit

Precast unit :

Material	*Quantity*	*Rate*, Rs	*Total amount*, Rs
Concrete 1 : 3 : 3	$1 \cdot 35 \times 10^{-2}$/m³	173/m³	2·40
3-mm mild steel wire	7·2m (0·4kg)	2·20/kg	0·88
Mould cost per casting		1·00	1·00
Labour			
Mason	0·1 day	10/day	1·00
Mazdoor	0·2 day	5/day	1·00
Total material + mould + labour cost			6·28
Assembly, including mortar (lump sum)			1·00
		Total	7·28

Full timber shelves

Material	*Quantity*	*Rate*, Rs	*Total amount*, Rs
Timber	$1 \cdot 35 \times 10^{-2}$ m³	1100/m³	14·90
Glue, nails etc. (lump sum)		..	0·60
Labour			
Carpenter	0·3 day	10/day	3·00
Mazdoor	0·3 day	5/day	1·50
		Total	20·00

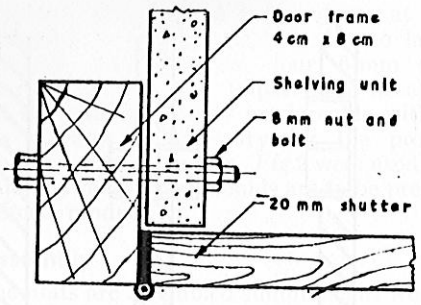

Fig 5 Details for fixing a shutter

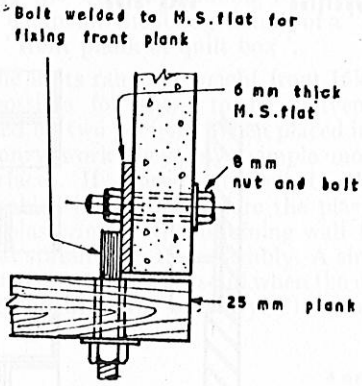

Fig 6 Details for fixing a front plank to the quilt box

Composite timber planks in masonry

These consist of: horizontal member in timber; projecting vertical sides in timber; back half-brick wall (or brick on edge); and back and sides 12cm thick plaster finish.

Material	*Quantity*	*Rate*, Rs	*Total amount*, Rs
Timber	$0 \cdot 2 \times 10^{-2}$ m³	1100/m³	8·00
Labour and glue etc. (lump sum)		..	2·90
Half-brick wall in 1 : 6 mortar	0·18m³	16/m³	2·90
Plastering	$21 \cdot 6 \times 10^{-2}$ m²	2·75/m³	0·60
		Total	13·50

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